Floristic ecotone between Quaternary sandridges and Jurassic sedimentary rocks near Mowla Bluff, Great Sandy Desert

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Abstract

There is a well-defined floristic ecotone between Quaternary sands and exposed Jurassic sedimentary rocks at the north-western margin of the Great Sandy Desert. Within the dunefields there is a dune-swale floristic gradient similar to that on central Australian sandridges, though different species are involved. The soil catena is also similar.

Introduction

There are few detailed quantitative descriptions of Australian arid sandridge vegetation (Wiedemann 1971, Fatchen and Barker 1979, Buckley 1981a, b), and none of the north-western Great Sandy Desert at a scale closer than that of Beard and Webb (1974) and Beard (1979). Vegetation pattern on sandridges at the edge of the Great Sandy Desert was therefore analysed to help fill this gap. In addition, the ecotone between Quaternary sandridges and Jurassic sedimentary rocks was examined as a step in elucidating the control of plant distribution by environmental factors. Since such factors are tightly correlated on the sandridges themselves (Buckley 1981b, 1982), their individual effects on plant distribution can only be separated by experimental manipulation in field or glasshouse, or by using atypical or marginal habitats such as this as "natural experiments".

Approximately 180 km south of Derby (Fig. 1), the dunefields of the Great Sandy Desert terminate abruptly in steep, gullied and broken slopes and cliffs. 40 m high, in the Jarlemai Siltstone (Casey 1958). The area 8 km southeast of Ardjorie station (123° 43′E, 18°46′S) was studied in August 1979. The site is shown in Figure 2, drawn from the 1967 1:80 000 aerial photograph (Mount Anderson E51-11 CAF 4040, run 7, photo 1385) and ground observations. Beard and Webb (1974, p. 45) on shallow sandridges area: *Eucalyptus brevifolia* - *Triodia intermedia* tree steppe on the scarps, *Acacia pachycarpa* - *Grevillea refracta* - *Triodia pungens* - *Triodia intermedia* shrub steppe on the sandy plateaux on top of the Edgar Ranges, and *Owenia reticulata* - *Triodia pungens* tree steppe on the desert sandridges. This site bears *Grevillea refracta* - *Triodia pungens* shrub steppe of Beard and Webb (1974, p. 45) on shallow sandridges over siltstone, with no *Owenia reticulata* in the immediate vicinity. The vegetation patterns described below are, of course, representative only of a small sector of these dunefields: elsewhere in the Great Sandy Desert, species such as *Velleia connata, Calytrix longiflora* and *Brunonia australis*, occur on different types of terrain and *Triodia pungens* is largely replaced by *Plectrachne schinzii* (J. S. Beard, pers. comm.).

Methods and results

Vegetation patterns were analysed firstly using two belt transects, and secondly by mapping the overall distributions of individual species on dune, swale and rock. The first transect ("sandridge") ran between the sandridges as marked on Figure 2. The second ("ecotone") ran from the first and perpendicular to it, to the head of the main gully. Each transect comprised a belt of contiguous 5 m square quadrats. Presence or absence of each species was recorded for each quadrat. These quadrat data were clustered by unconstrained hierarchical polythetic agglomeration using euclidean distance and the error sum of squares and followed by relocation (cf. Buckley 1981a). Soils from 0.1 m and 2.0 m depth on ridge crest and central swale were analysed for organic carbon and total nitrogen concentrations, extractable phosphorus, sodium, potassium and calcium and pH by the methods described in Buckley (1982). Floristic patterns were then related to substrate features as far as possible. Results are shown in Figure 3 and Tables 1 to 4.

Within the sandridge transect there is a clear floristic division between the swale assemblage on the one hand and the dune flanks and dune crests on the other. This is well-demonstrated by the binary frequency ratio tabulations for the two-cluster stage in Table 1. These indicate that 16 of the 27 species in the sandridge transect are entirely absent from the swale zone. Only one, *Dampiera candicans,* is entirely confined to the swale, but four more (*Eragrostis eriopoda, Goodenia scaevolina, Gonocarpus eremophilus* and *Mirbelia viminalis*) are distinctly more frequent in the swale than on the flanks or crests.

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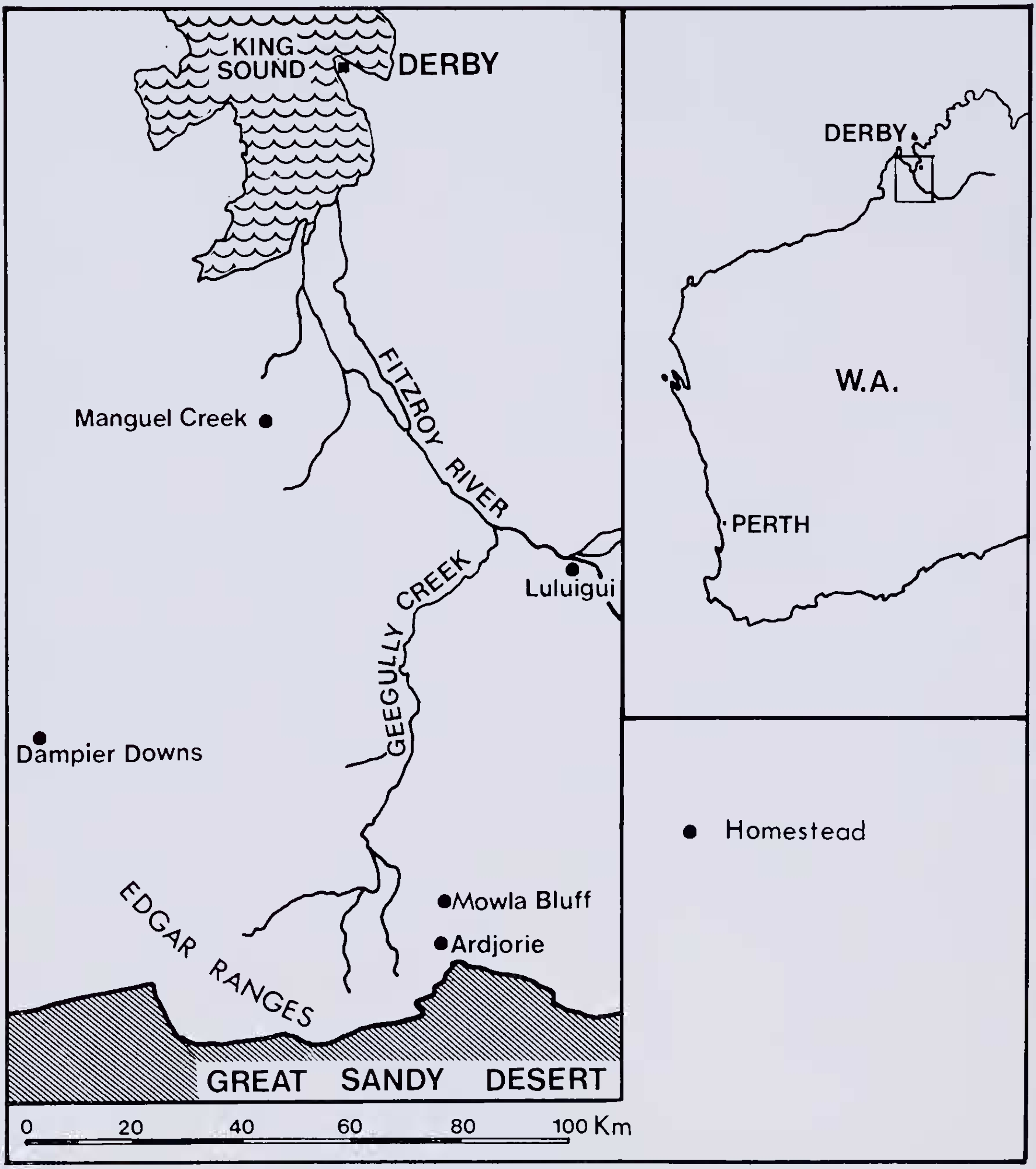

Figure 1.—Site location. Shaded area is Great Sandy Desert *sensu* Beard (1979); *Owenia reticulata-Triodia pungens* tree steppe between sandridges. Sandridges north of shaded area bear pindan. Site shown in Figure 2 is 8 km southeast of Ardjorie.

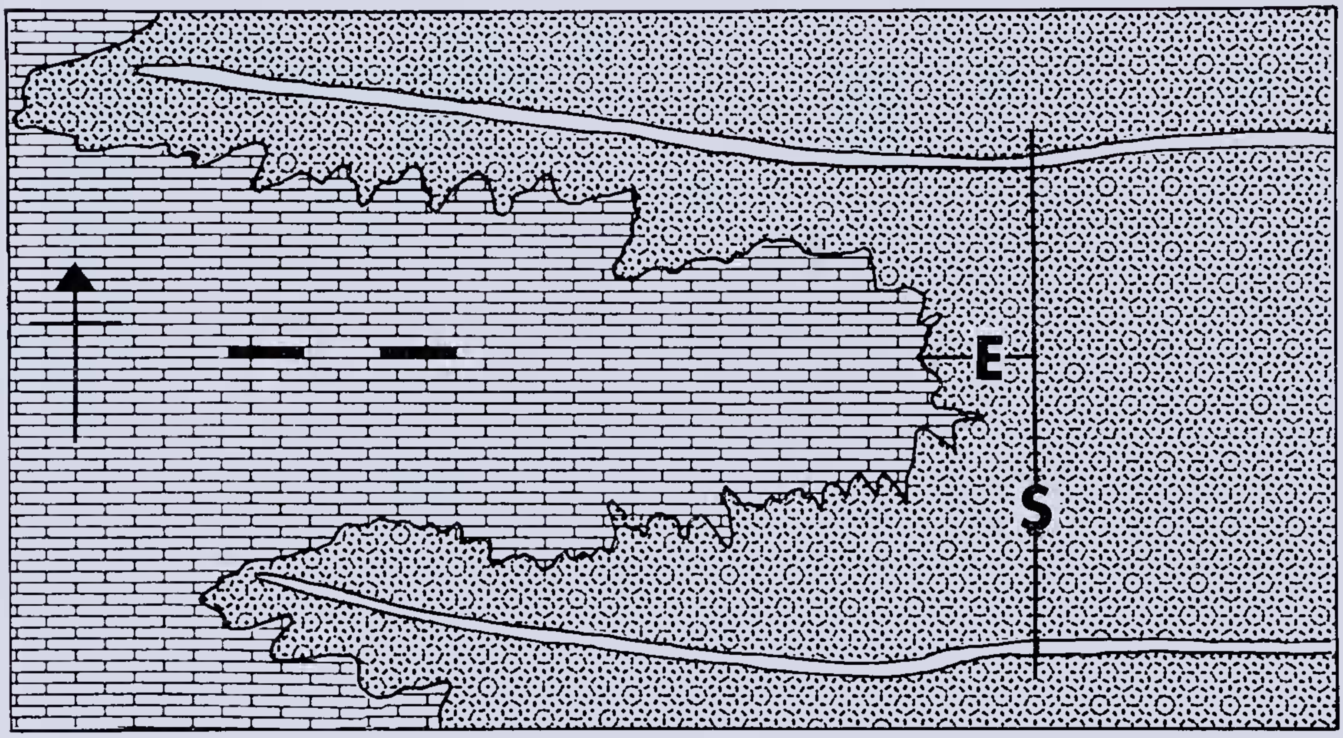

Figure 2.—Site plan showing open dunecrests (white), vegetated flanks and swales (stippled), and heavily gullied Jurassic Jarlemai Siltstone (blocked), together with sandridge (S) and ecotone (E) transects. Scale bar 300 m.

Table 1

Cluster statistics for sandridge transect (to be read in conjunction with Fig. 3)

Species	Collection No.	Main Transect: BFRs					
		4-cluster stage				2-cluster	
		SW (15)	FL (79)	ND (10)	SD (18)	SW (17)	FD (105)
Triodia pungens R.Br.	4074	1·0	1·0	1·0	1·0	1·0	1·0
Aristida browniana Henr.	4082	1·2	1·2	0·9	....	1·0	1·0
Eragrostis sp.aff. *eriopoda* Benth.	4064	0·7	....	11·1	....	2·0	0·9
Dampiera candicans F.Muell.	4048	7·1	....	1·5	....	7·1	....
Goodenia scaevolina F.Muell.	4049	6·1	0·4	....	....	5·4	0·3
Gonocarpus eremophilus Orchard	4058	3·4	0·9	....	....	3·0	0·7
Mirbeliu viminalis (A.Cunn.) C.A. Gard.	4055	2·7	1·0	....	....	2·4	0·8
Acaciu hilliana Maiden	4072	0·9	1·2	....	0·8	0·8	1·0
Grevillea refracta R.Br.	4039	1·4	1·1	1·0	0·4	1·4	0·9
Halgania solanacea F.Muell.	4053	0·7	1·0	2·2	0·6	0·7	1·1
Fimbristylis squarrulosa F.Muell.	4059	0·6	1·0	0·9	1·6	0·6	1·1
Acacia difficilis Maiden	4043	....	....	....	6·8	....	1·2
Synaptantha tillueacea (F.Muell.) Hook.f.	4069	....	....	....	6·8	....	1·2
Tephrosia nematophylla F.Muell.	4067	....	0·5	....	4·9	....	1·2
Burtonia simplicifolia F.Muell. ex Tate	4041	....	1·0	....	2·6	....	1·2
Ptilotus fusiformis (R.Br.) Poir.	4052	....	1·0	....	2·3	....	1·2
Jacksonia aculeuta W.V.Fitzg.	4047	....	1·2	....	1·7	....	1·2
Hibiscus solanifolius F.Muell.	4068	....	0·5	4·1	2·3	....	1·2
Eucalyptus setosa Schau	4040	....	0·9	2·4	1·4	....	1·2
Borreria australiana Specht	4066	....	1·2	3·1	....	....	1·2
Sida sp.aff. *virgata* Hook.	4071	....	0·8	6·1	....	....	1·2
Didymotheca tepperi H.Water	4060	....	....	12·2	....	....	1·2
Gardenia resinosu F.Muell.	4063	....	1·6	....	....	....	1·2
Calytrix longiflora F.Muell.	4017	....	1·6	....	....	....	1·2
Olax sp. nov.	4050	....	1·6	....	....	....	1·2
Velleia connata F.Muell.	4030	....	1·6	....	....	....	1·2
Brunonia australis Sm.	4054	....	1·6	....	....	....	1·2

Table shows binary frequency ratios (BFRs) for each species in each cluster at the 4- and 2-cluster stages respectively. SW, swale; FL, flank; ND, north dune; SD, south dune; FD, flank and dune. Figures in brackets below abbreviations are total numbers of quadrats in each cluster. The number in the swale cluster changes between 4- and 2-cluster stage owing to relocation of two quadrats.

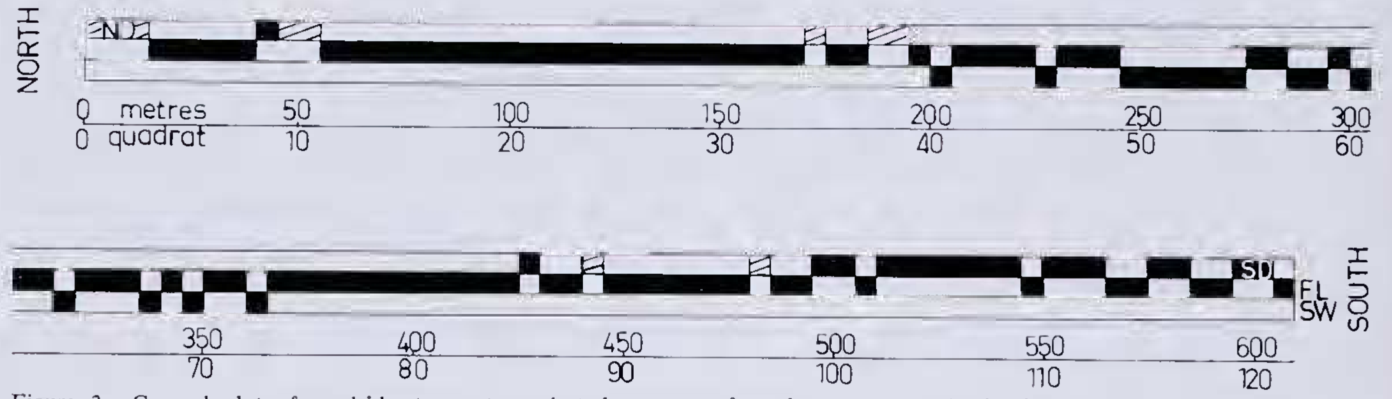

Figure 3.—Ground plot of sandridge-transect quadrat-clusters at four-cluster stage (split into two sections). Top bar shows quadrats in north-dune cluster (shaded) and south-dune cluster (solid); centre bar shows quadrats in flank cluster, and bottom bar those in swale cluster.

Table 2

Species distribution in ecotone transect, with collection numbers of voucher specimens

Species	Collection No.	(west) . . . Metres . . . (east) 0 50 100 150
Triodia sp.aff. *pungens* R.Br.	4075	**
Hibiscus leptocladus Benth.	4077	**** * *** ** *
Eragrostis eriopoda Benth.	4076	********** * **
Grevillea wickhamii Meissn.	4042	* ** ** * ** * *
Grevillea refracta R.Br.	4039	** ** ** ************* * ***
Fimbristylis squarrulosa F.Muell.	4059	* ** * ** ****** *** ******
Dampiera candicans F.Muell.	4048	**** *** **
Ptilotus calostachyus (F.Muell.) F.Muell.	4080	******
Ptilotus kenneallyanus Benl.	4078	*
Pterigeron odorus (F.Muell.) Benth.	4079	*
Quadrat No.		0 10 20 30

A further four (*Acacia hilliana, Grevillea refracta, Halgania solanacea* and *Fimbristylis squarrulosa*) have similar frequencies in each cluster, and *Triodia pungens* and *Aristida browniana* are uniformly abundant. The swale quadrats are not all contiguous (Fig. 3), so the vegetation gradient is not as clearcut as the above might suggest, but they are confined to a narrow zone in the topographic swale.

Examining the flank-crest complex in more detail the binary frequency ratios for the four-cluster stage (Table 1, Fig. 3) show that a broad flank cluster can be separated from two smaller dune clusters, which are themselves substantially different in floristic composition, and correspond respectively to the northern and southern dunes in Figure 2. Again, the clusters overlap somewhat on the ground, but quadrats bearing the dune floristic assemblages are confined to the topographic dunes indicating a real floristic gradient between dune and swale. Five species, none common, are confined to the flank assemblage and three of the more abundant species, present in both swale and flank assemblages, are entirely absent from both dune groups. Of the 19 species in the dune assemblage as a whole, only six are present in both the north dune and the south dune cluster, a remarkably clear floristic separation. Many are shared with the flank assemblage and only *Acacia difficilis, Synaptantha tillaeacea* and *Didymotheca tepperi* are confined to one or other of the dune assemblages, the first two species to the southern and the third to the northern dune. Hence, cluster analysis of the sandridge transect demonstrates a dune-swale floristic gradient comparable to that on the sandridges of the Simpson and Gibson Deserts (Buckley 1981a, b).

Table 3

Additional species recorded from site but not transects, with collection numbers of voucher specimens.

Gullies	
Acacia monticola J. M. Black	4085
Triumfetta plumigera J. M. Black	4084
Dunefields east of area in Figure 2	
Ptilotus polystachyus (Gaud.) F. Muell.	4091
Codonocarpus cotinifolius (Desf.) F. Muell.	4086
Acacia stipuligera F. Muell.	4088
Comesperma sylvestre Lindl.	4089
Dunes shown in Figure 2	
Plechtrachne sp.aff. *pungens*	4073
Psoralea pustulata F. Muell.	4090
Dodonaea coriacea (Ewart et Davies) McGillivray	4046
Rulingia loxophylla F. Muell.	4056
Halgania glabra J. M. Black	4057
Newcastelia spodiotricha F. Muell.	4045
Dampiera cinerea Ewart et Davies	4044

The shorter ecotone transect, from the centre swale of the sandridge transect to the head of the main gully, contains five species not found in the sandridge transect: *Hibiscus leptocladus, Grevillea wickhamii, Ptilotus calostachyus, Ptilotus kenneallyanus* and *Pterigeron odorus*. With the exception of the uncommon *P. odorus* all these species were also

Table 4

Soils, Mowla Bluff dunes

	Organic carbon*	Total nitrogen*	Extractable phosphorus*	Extractable potassium*	Extractable calcium*	1:5 pH*
Dune, 5–10 cm	825	75	9	33	14	6·55
Dune, 100 cm	390	40	2	40	41	6·75
Swale, 5–10 cm	1 400	130	5	85	39	6·57
Swale, 100 cm	750	80	13	55	21	6·50

* Units are ppm.

recorded from within the gullies as were the five species shared with the sandridge transect: *Triodia pungens, Eragrostis eriopoda, Grevillea refracta, Fimbristylis squarrulosa* and *Dampiera candicans*. Of these latter five, only *Dampiera candicans* is a swale species the others being widespread in this area. Though short, the ecotone transect (Table 2) shows a floristic gradient from the swale soils to increasingly shallow skeletal sandy soils over siltstone. Table 3 lists additional species common in the gullies but not found in the dunefields, and dunefield species present at the site but not in either transect.

The distributions of a number of species, e.g. *Grevillea refracta,* take the form of oval patches with their major axes along the main gully centre-line, reaching west along the gully margins and east a short distance into the swale, in association with the shallower soils. Combined with the transects, this evidence therefore indicates two major substrate-controlled floristic gradients: firstly, from dune to swale as on sandridges throughout arid Australia; and secondly, from the red clayey swale sands through increasingly shallow sandy soils over sandstone to the Jurassic sandstone gullies. Substrate factors associated with this gradient were not investigated in any detail, since plants in the gullies are rooted in narrow cracks and it was not feasible to extract soils for analysis. Analyses of dune and swale soils (Table 4) indicate that dune-swale ratios for total carbon and nitrogen, extractable phosphorus, potassium and calcium, and pH are comparable to those for the central Australian sandridges (Buckley 1982), save that the dune-swale nitrogen gradient is less pronounced on the relatively low Mowla Bluff dunes. Actual values for organic soil carbon and total soil nitrogen contents at Mowla Bluff are not significantly different from those on the central Australian sandridges, given the overall variability and the low relief at Mowla Bluff; in contrast to the homogeneous crest sands on the higher central Australian ridges; however, carbon and nitrogen levels at Mowla Bluff are significantly higher at 5-10 cm depth than at 1 m. Both central Australian and Mowla Bluff sandridges lack pronounced dune-swale catenary variation in extractable phosphorus, potassium or calcium content, but absolute values are consistently lower at Mowla Bluff than in the Gibson or Simpson Deserts, being around 10-40% of the central Australian mean for phosphorus, 20-55% for potassium, and 2.5-8% for calcium; pH values, however, are very similar. Sample numbers were insufficient to test whether these latter differences between the Great Sandy Desert and the central Australian deserts are consistent; if they are, they could perhaps account in part, together with climatic patterns and phytogeographic history, for the floristic differences between the two regions. On the central Australian sandridges the dune-swale floristic catena is associated with corresponding patterns in soil texture, moisture relations and nutrient status (Buckley 1982). These were not studied in such detail at Mowla Bluff, but the textural patterns are similar and the evidence presented above indicates that the soil nitrogen catena, a major factor in central Australia, is similar at this site on the north-western margin of the Great Sandy Desert. Hence it appears probable that similar processes operate to control the dune-swale floristic catena.

Conclusions

The following conclusions may be drawn: (a) there is a floristic ecotone between the red clayey sands of the dunefield swales and the Jurassic sedimentary rocks exposed in gullied cliffs at the north-western margin of the Great Sandy Desert dunefields; (b) there is also a floristic catena on the sandridges themselves, comparable to that on the central Australian sandridges; (c) this catena is associated with corresponding patterns in soil texture and nitrogen status, as on central Australian sandridges.

References

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